

Marine Water Pollution: Harmful Algal Blooms

Brown Tides, *Aureococcus anophagefferens*

Background

Brown tide blooms, caused by the rapid growth of a minute alga, *Aureococcus anophagefferens*, caused the demise of the scallop industry in coastal bays of Long Island, NY in the mid-1980s. These blooms were suspected at the same time in the Barnegat Bay/Little Egg Harbor (BB/LEH) system because of the discoloration of the water, but the organism was not documented until 1988. The Brown Tide Bloom Index in the table below relates brown tide abundances to known negative impacts to natural resources.² Brown tide abundances as low as 35,000 cells ml⁻¹ may cause a reduction in the growth of juvenile hard clams, *Mercenaria mercenaria*. Because of limited information during a reported 1999 brown tide bloom, the Division of Science Research and Technology (DSRT) established the Brown Tide Assessment Project to assess brown tide blooms in Barnegat Bay-Little Egg Harbor (BB/LEH) from 2000-2002, in cooperation with several partners, through 1) mapping the abundances of the brown tide using the Brown Tide Bloom Index; (2) assessing the relationship between the brown tide abundances and environmental factors (e.g., salinity, temperature, nitrogen species); and 3) analysis of the risk of brown tide blooms to submerged aquatic vegetation (SAV) communities. SAV communities are important spawning and nursery habitat for juvenile fish and shellfish and may be negatively impacted by brown tide blooms of longer duration (> 2 months).

Status and Trends

Over the three bloom years, 2000-2002, the highest *A. anophagefferens* abundances (>10⁶ cells ml⁻¹), including category 3 and Category 2 blooms (table below) recurred during each of the 3 years of sampling and covered significant geographic areas of the BB/LEH estuary.³ In Little Egg Harbor, the Figure of maps of median and maximum *A. anophagefferens* (BT) abundance (cells ml⁻¹) for the April to September sampling period for Years 2000, 2001, and 2002 in Barnegat Bay/Little Egg Harbor, NJ, brown tide abundances were well above the levels that have been reported to cause negative impacts on shellfish. While category 3 blooms were generally associated with warmer water temperatures (>16 °C (60.8 °F) and higher salinity (>25–26 parts per thousand, ppt), these factors were not sufficient to explain the timing or distribution of *A. anophagefferens* blooms. There was no significant relationship between brown tide abundances and dissolved organic nitrogen

measured in 2002 but this was consistent with other studies. Extended drought conditions, with corresponding low freshwater inputs and elevated bay water salinity occurring during this time may have been contributing factors conducive to brown tide blooms in BB/LEH as they have been in other bays.⁴ This study showed that over 50% of the submerged aquatic vegetation (SAV) habitat located in Barnegat Bay/Little Egg Harbor was categorized as having a high frequency of category 2 or 3 blooms for all 3 years (Figure Map of Median Bloom Category vs. SAV beds for Years 2000, 2001, 2002.). This was only a risk assessment and the study did not directly assess the adverse effects on SAV habitat but the results indicate that analysis of brown tide impacts on SAV habitat should be studied because this habitat is vulnerable to elevated brown tide blooms.

Outlook and Implications

This preliminary analysis suggests that brown tide blooms occurring in concentrations high enough and for a long enough duration may pose a significant risk to Barnegat Bay-Little Egg Harbor's hard clam population and submerged aquatic vegetation (i.e., eelgrass *Zostera marina*) beds. These findings are particularly important because over 70% of the state's eelgrass beds are located in Barnegat Bay and Little Egg Harbor estuary system. More investigation is needed to provide greater elucidation on the comparative importance of maximum bloom concentration vs. bloom duration on SAV health and productivity.

Brown Tide Bloom Index (Gastrich & Wazniak, 2002)

CATEGORY 1: < 35,000 *Aureococcus anophagefferens* cells ml⁻¹
(No observed impacts)

CATEGORY 2: ≥ 35,000 to < 200,000 cells ml⁻¹

- Reduction in growth of juvenile hard clams, *Mercenaria mercenaria*
- Reduced feeding rates in adult hard clams
- Growth reduction in mussels (*Mytilus edulis*) and bay scallops (*Argopecten irradians*)

CATEGORY 3: ≥ 200,000 cells ml⁻¹

- Water becomes discolored yellow-brown
- Feeding rates of mussels severely reduced
- Recruitment failures of bay scallops and high mortalities
- No significant growth of juvenile hard clams
- Negative impacts to eelgrass due to algal shading

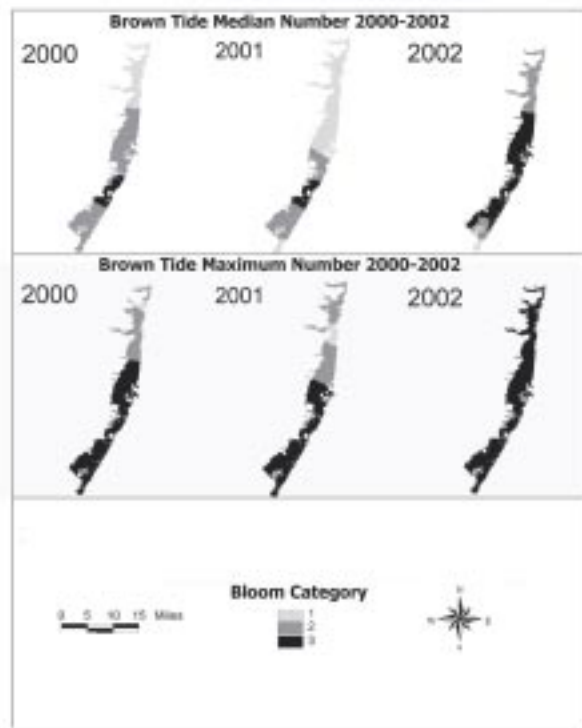
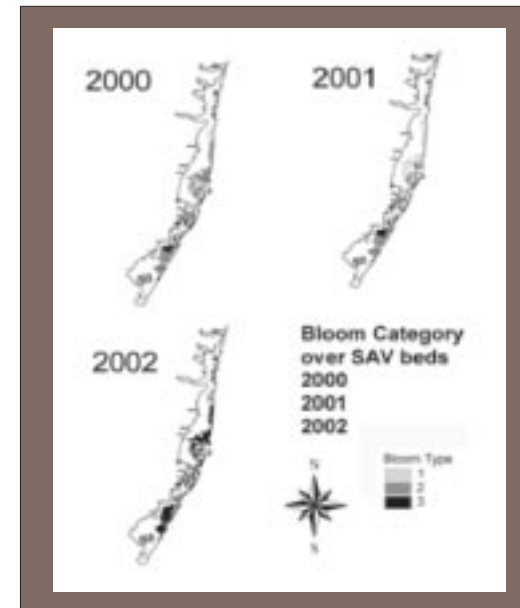


Figure. Maps of median and maximum *A. anophagefferens* (BT) abundance (cells ml^{-1}) for the April to September sampling period for Years 2000, 2001, and 2002 in Barnegat Bay/Little Egg Harbor, NJ.

Figure. Map of Median Bloom Category vs. SAV beds for Years 2000, 2001, 2002.



References

- ¹ Anderson, D.M., B.A., Keafer, D.M. Kulis, R.M. Waters and R. Nuzzi. 1993. An immunofluorescent survey of the brown tide chrysophyte *Aureococcus anophagefferens* along the northeast coast of the United States. *J. Plankton Res.* 15: 563-580.
- ² Gastrich, M.D. and C. E. Wazniak. 2002. A Brown Tide Bloom Index Based on the Potential Harmful Effects of the Brown Tide Alga, *Aureococcus anophagefferens*. *Aquatic Ecosystems Health & Management*. Vol. 33, No. 2, pp. 175-190.
- ³ Gastrich, M. D.; R. Lathrop, S. Haag, M.P. Weinstein, M. Danko, D. A. Caron, R. Schaffner. 2004. Assessment of brown tide blooms, caused by *Aureococcus anophagefferens*, and contributing factors in New Jersey coastal bays: 2000-2002. *Harmful Algae*, Special issue: Brown Tides - Edited by M. Lomas and C. Gobler. Vol 3: 305-320.
- ⁴ Bricelj, V.M. and D.J. Lonsdale. 1997. *Aureococcus anophagefferens*: Causes and ecological consequences of brown tides in U.S. mid-Atlantic coastal waters. *Limnol. Oceanogr.* 42 (Part 2): 1023-1038.

More Information

Graphic displays of the spatial patterns of the brown tide blooms and environmental factors can be viewed at: <http://crssa.rutgers.edu/projects/btide/index.html>. A Research Project Summary is available at: <http://www.state.nj.us/dep/dsr/browntide/bt-rps.pdf>